

**A B S T R A C T**

The invention provides a process, catalyst and apparatus for carrying out the water-gas shift reaction comprising employing a low-pyrophoricity water-gas shift reaction catalyst; wherein the low-pyrophoricity water-gas shift reaction catalyst comprises a solid high heat capacity particulate support impregnated with: (i) a reducible metal oxide and (ii) a catalytic agent.

100-225-000-000

UNITED STATES PATENT AND TRADEMARK OFFICE  
DOCUMENT CLASSIFICATION BARCODE SHEET



# Drawings

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Figure 1  
**Activities (lines) and pyrophoricity (columns) of**  
**FeCr, CuO/ZnO/Al<sub>2</sub>O<sub>3</sub>, CuO/CeO<sub>2</sub> and CuO/CeO<sub>2</sub>/Al<sub>2</sub>O<sub>3</sub>**  
**2% CO, 10% H<sub>2</sub>O, 20% H<sub>2</sub>, 5% CO<sub>2</sub>; VHSV = 5,000 h<sup>-1</sup>**

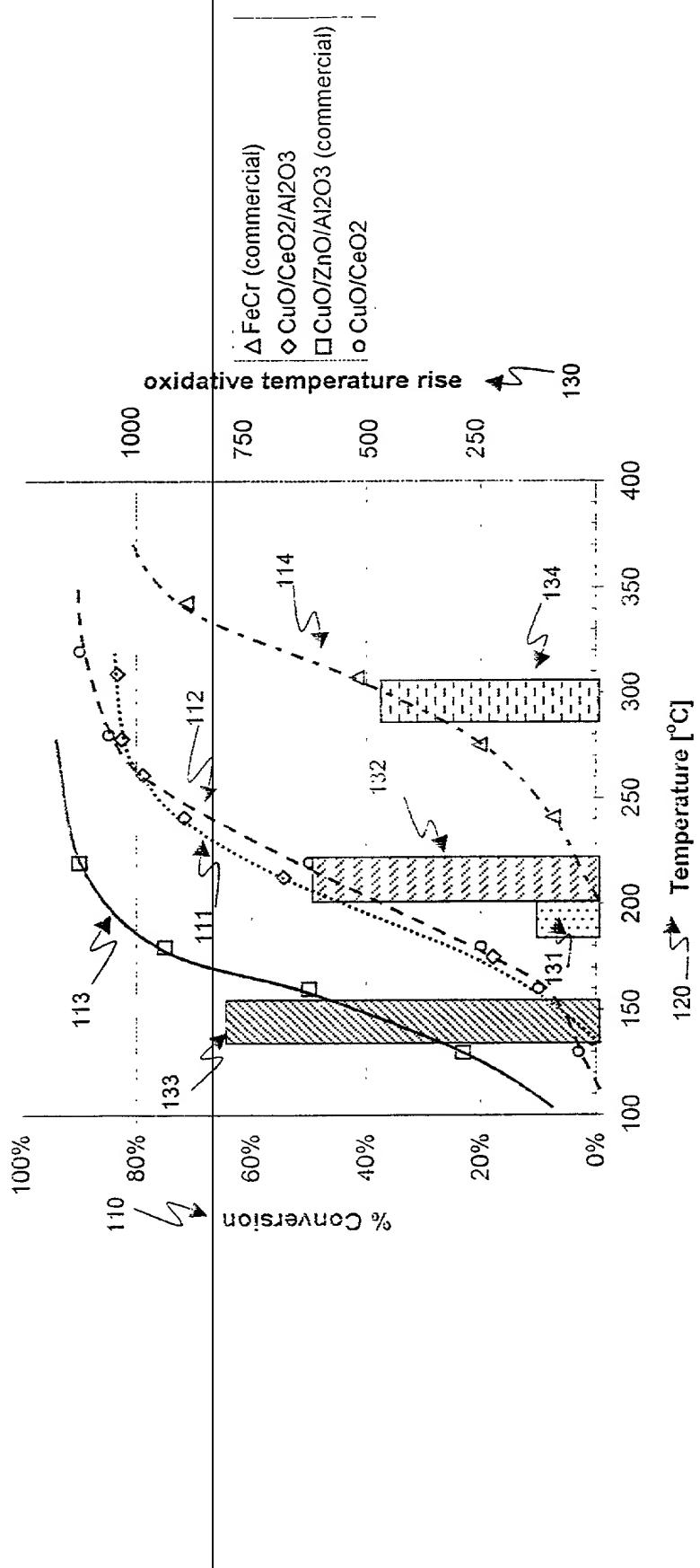
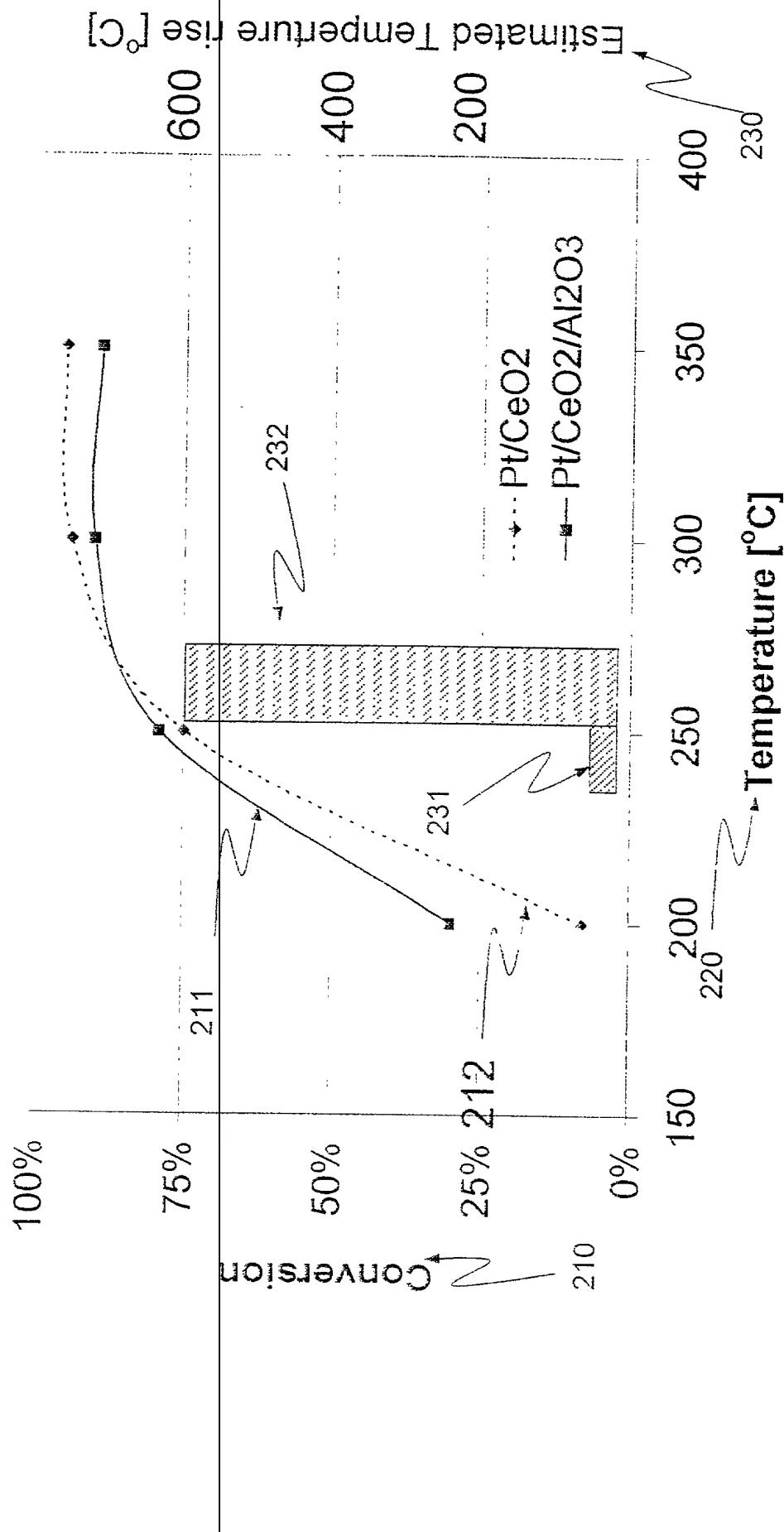
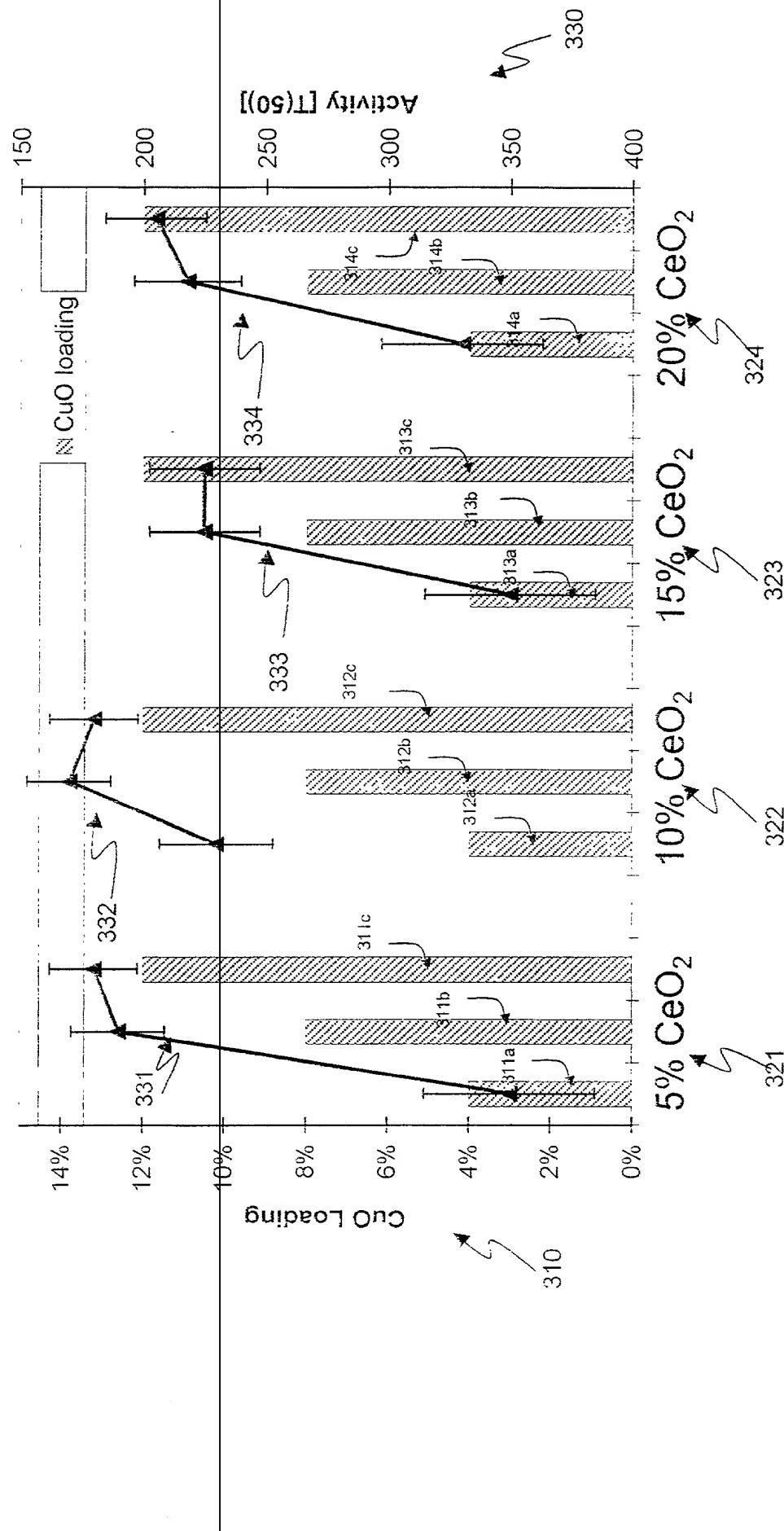


Figure 2: Comparison of activity (lines) and pyrophoricity (columns) of  
Pt/CeO<sub>2</sub> and Pt/CeO<sub>2</sub>/Al<sub>2</sub>O<sub>3</sub> catalysts  
0.5% CO, 20% H<sub>2</sub>, +10% H<sub>2</sub>O, WHSV=24,000 h<sup>-1</sup>



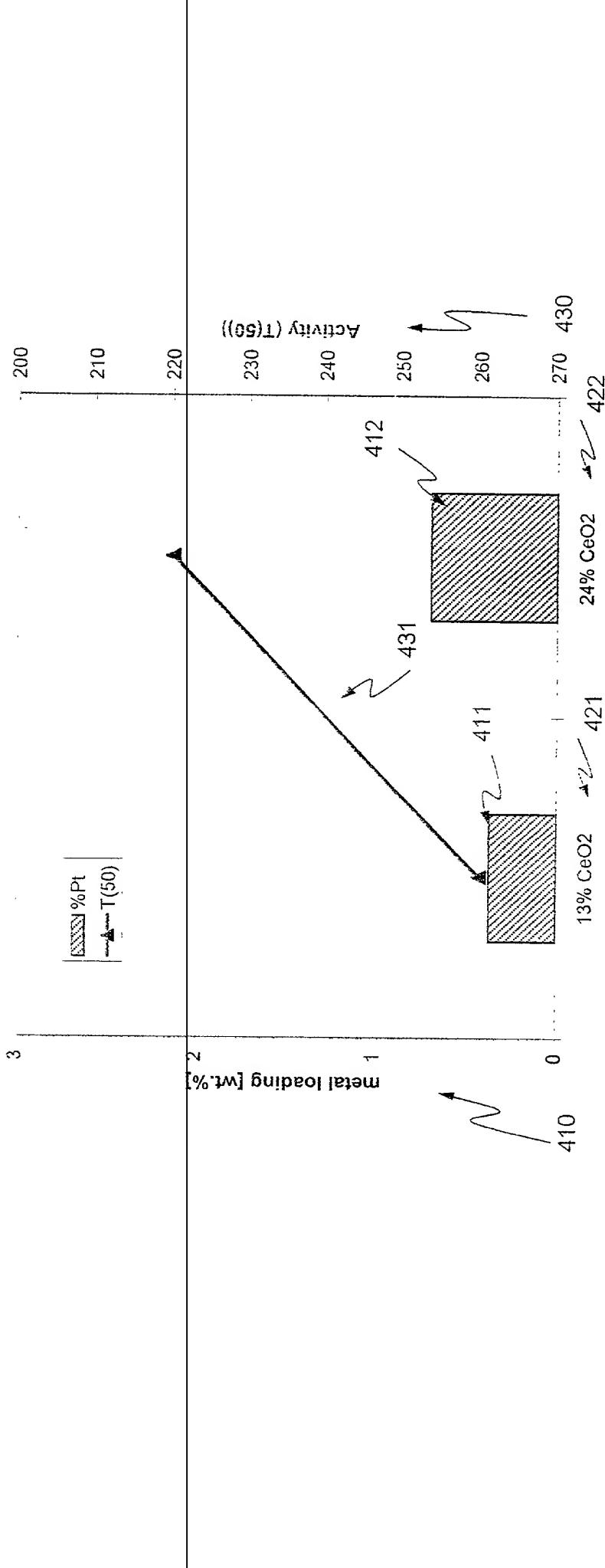
**Dependence of WGS activity on Ce- and Cu-loading  
(18,846+38, samples WR-66,75, exp. WR-67,76,78)**

test conditions: 2% CO, 20% H<sub>2</sub>, +10% H<sub>2</sub>O balance N<sub>2</sub> WHSV = 30,000 h<sup>-1</sup>

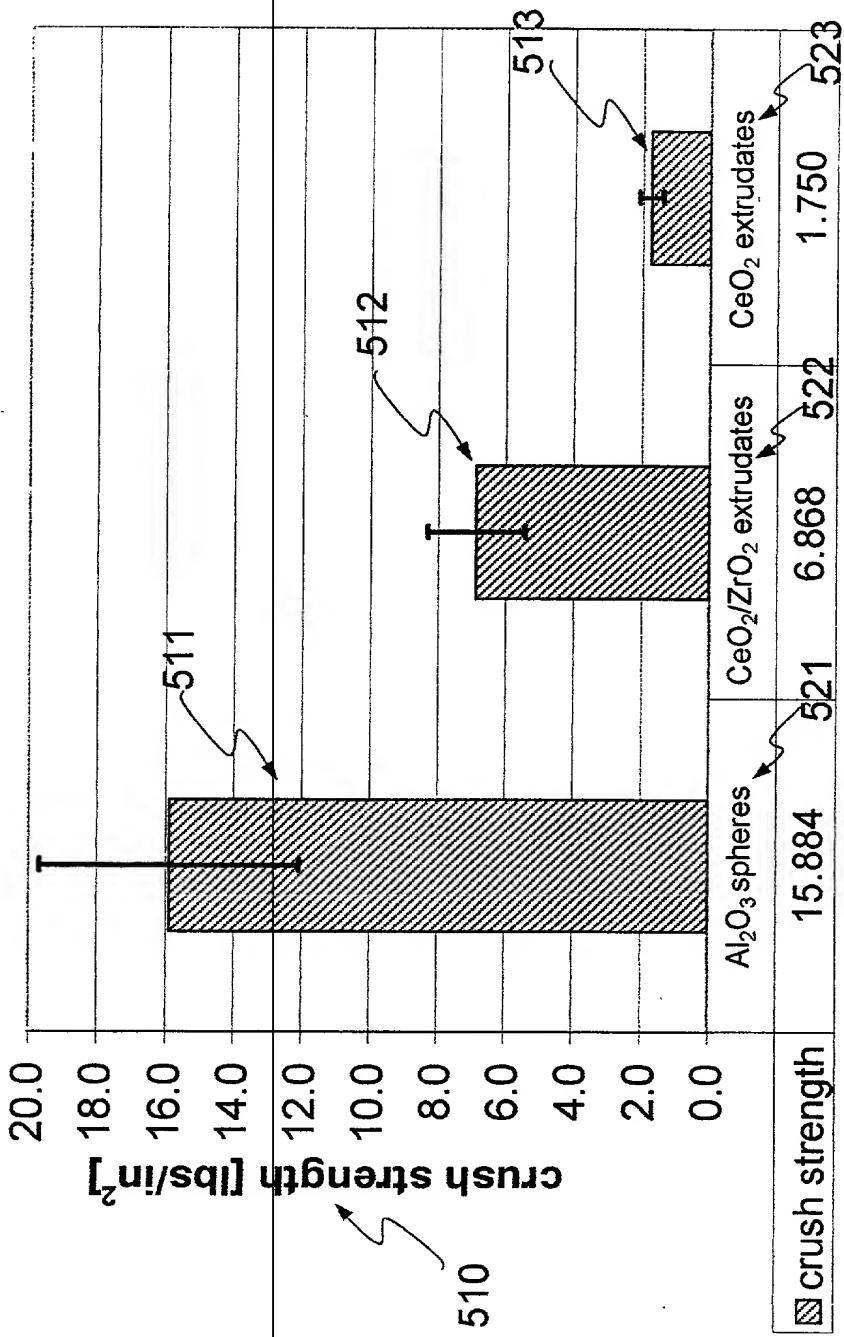


# Effect of Ce and Pt loading on the activity of Pt/CeO<sub>2</sub>/Al<sub>2</sub>O<sub>3</sub> catalysts

0.5% CO, 20% H<sub>2</sub>, +10% H<sub>2</sub>O, WHSV=24,000 h<sup>-1</sup>



Crush strength of catalyst support particles  
Average and standard deviation of 20 samples



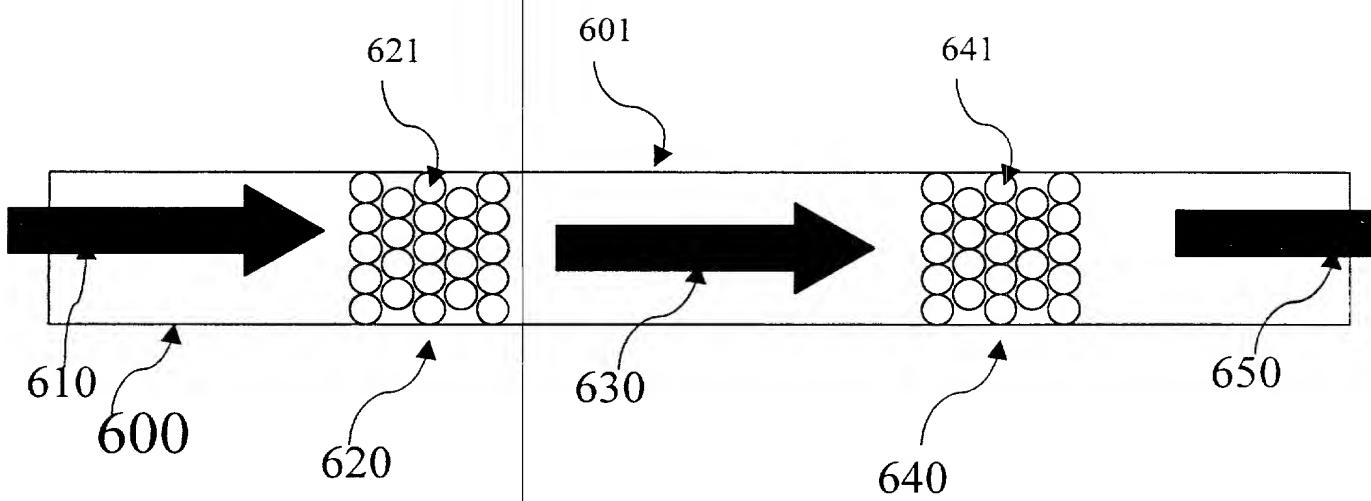
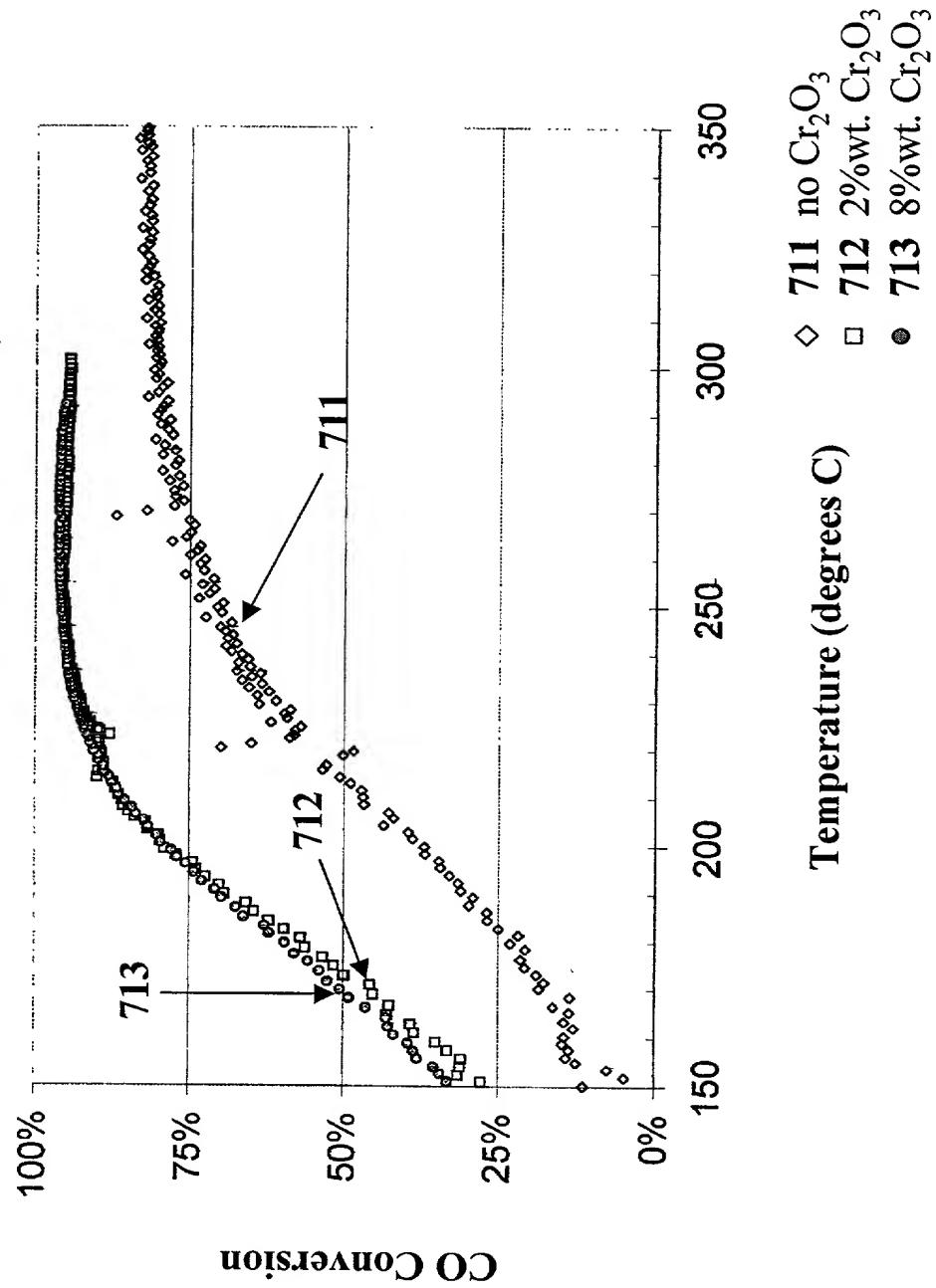
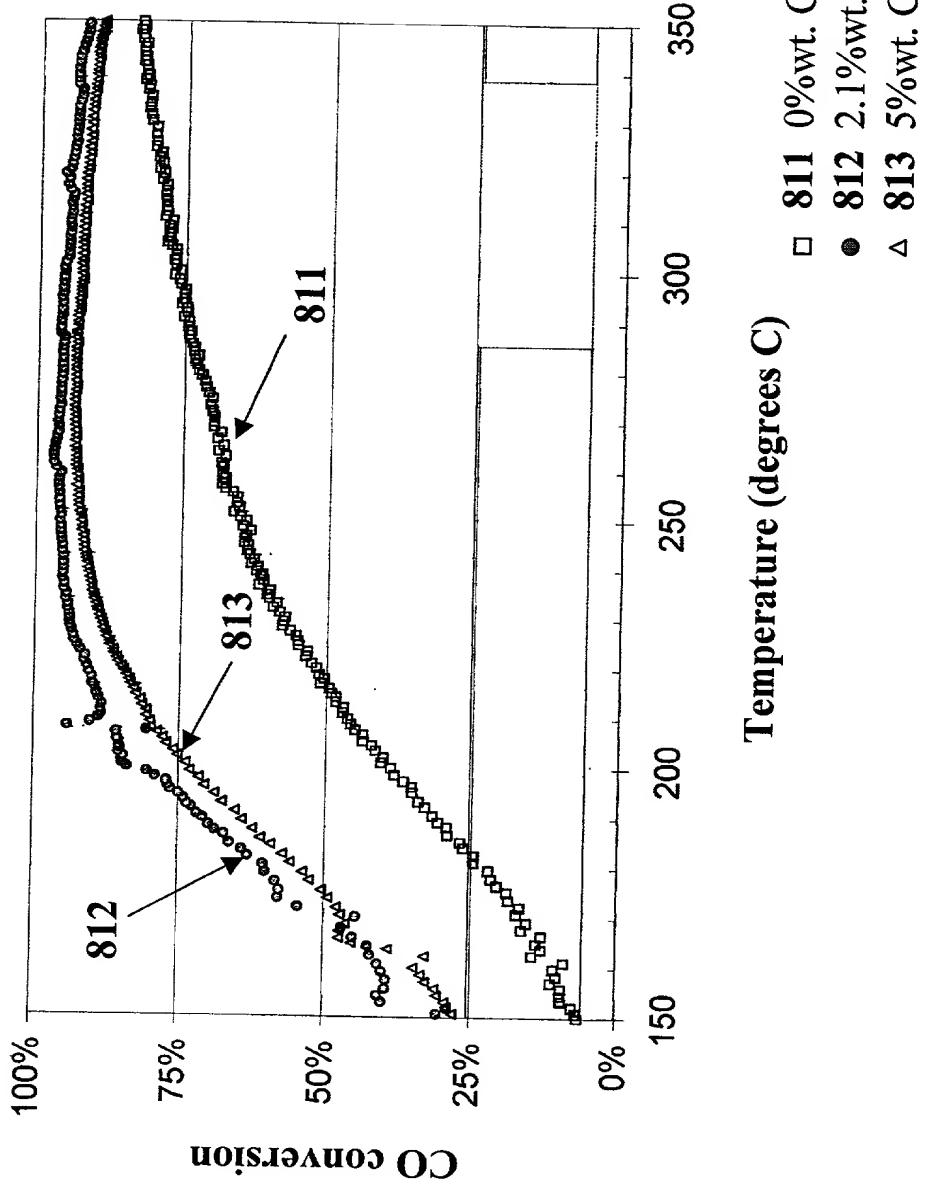


FIG. 6

**Figure 7: Effect of Cr<sub>2</sub>O<sub>3</sub> Level on the Catalytic Activity of CuO/Al<sub>2</sub>O<sub>3</sub> WGS Reaction Catalysts**



**Figure 8:** Effect of  $\text{Cr}_2\text{O}_3$  Level on the Catalytic Activity of  $\text{CuO}/\text{CeO}_2/\text{Al}_2\text{O}_3$  WGS Reaction Catalysts



**Figure 9:** Effect of the Sequence of Synthetic Steps on the Catalytic Activity of CuO/Cr<sub>2</sub>O<sub>3</sub>/CeO<sub>2</sub>/Al<sub>2</sub>O<sub>3</sub> WGS Reaction Catalysts

